Scope of Services
Phase 1A: Flood Damage Assessment
Economic Analysis of the Delaware Bay Shoreline Adaptation Alternatives
Task Order No. 1A – Structures/Affected Property Inventory
January 13, 2011
Johnson, Mirmiran & Thompson, Inc.

Background
Johnson, Mirmiran & Thompson, Inc. (JMT) has prepared Task Order No. 1A – Phase IA: Flood Damage Assessment for the *Economic Analysis of the Delaware Bay Shoreline Adaptation Alternatives* project sponsored by Delaware Department of Natural Resources and Environmental Control (DNREC). The purpose of Phase IA is to obtain and assess data for inventorying structures and conducting a flood damage assessment and associated BCA for flood prone structures/facilities in each of the seven communities within the study area. It is anticipated that Phase II and subsequent phases and related task orders will be based on the findings of Phase I. Phase I anticipates that the General Scope of Services prepared by JMT and reviewed by DNREC dated January 13 2011 comprises the main tasks to be accomplished for the project.

Attached is a figure depicting the location of the seven communities to be evaluated for this project. Also attached is a figure focusing on each of the counties (Kent and Sussex) which depicts the limits of the study area. The following table summarizes the number of structures and length of roads to be inventoried as part of this task order. The numbers included in the table were derived from review of available aerial photography and GIS data layers.

Table 1: Estimated Structures and Roads Length by Community

Community	# Structures	Road Length (feet)
Bowers/S. Bowers Beach	320	27740
Broadkill Beach	456	37880
Kitts Hummock	112	11600
Pickering Beach	45	8450
Prime Hook	188	24550
Slaughter Beach	337	40980
TOTAL	***1458***	***151200***

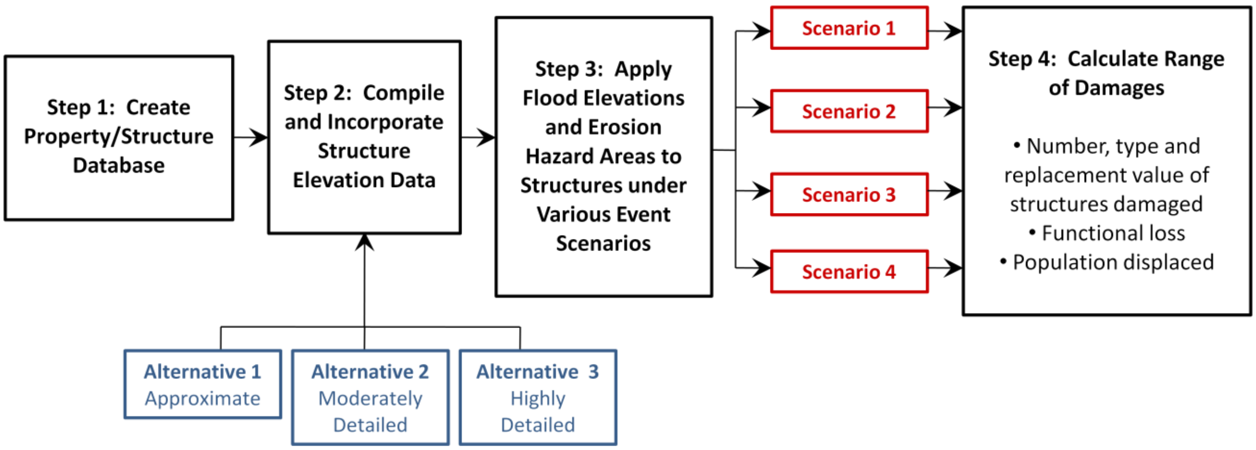
Scope of Services
Economic analyses using FEMA Benefit Cost Assessment software/models require three main categories of data to complete the flood damage assessment component:

- Affected property/structures inventory to determine potential risk to flooding and determine estimated damages
- Coastal hazard modeling to determine hazard elevations and frequency and duration of flooding for any given structure

- Shoreline adaptation alternatives development to determine flood reduction potential and project costs

Flood Damage Assessment Alternatives

The following “Straw-man” approach for Delaware Bay Flood Damage Assessments demonstrates the steps required to complete the flood damage assessment:



This scope of services focuses on the collection of data for the structures inventory component which is depicted as Step 1 and Step 2 in the flow diagram. Steps 3 and 4 will be completed once concurrence is achieved on the coastal hazard mapping information to be used for the project (a separate task order).

The level of detail at which the flood damage assessments are performed depends primarily on the form of structure elevation data. Four alternatives are suggested below for collecting elevation data, ranging from approximate to highly detailed. Note that these proposed alternatives are not necessarily exclusive and could be combined, modified, or augmented at the discretion of the study team.

Alternative 1 – Approximate: Develop a set of assumptions on property elevations and property type based on local knowledge obtained from property owners, community representatives, and/or state officials. Properties could be assigned to categories of structure elevations (e.g. 40% of structures built to slab on grade, 20% of structures elevated ~3 ft., 20% of structures elevated ~6 ft., 10% of structures elevated ~10 ft., 10% of structures elevated ~14+ ft.). Drive-by structure surveys could be used to assist in estimating the number of structures which fall within assigned categories for each community.

Alternative 2 – Moderately Detailed: Use existing LiDAR and parcel information to estimate structure elevations. This method would yield a unique elevation for each individual structure; a significant distinction from data produced through Alternative 1. Aerial imagery and Google street view products could be used to validate and/or modify structure elevation estimates.

Alternative 3A – Highly Detailed – Land Surveying: Use traditional survey methods (including GPS), survey crews, elevation certificates, and/or another existing source to collect detailed lowest floor/first floor elevation data and road elevation data. GPS or traditional survey instruments and survey crews would require collection of new data while the use of elevation certificates would allow the study to take advantage of existing data (if it is available). Elevation certificates likely provide the highest level detail; however, the availability of this data is currently unknown.

Alternative 3B – Highly Detailed Mobile- LiDAR technology: Use mobile LiDAR data, survey crews, elevation certificates, and/or another existing source to collect detailed lowest floor/first floor elevation data. Mobile LiDAR and survey crews would require collection of new data while the use of elevation certificates would allow the study to take advantage of existing data (if it is available). Elevation certificates likely provide the highest level detail; however, the availability of this data is currently unknown.

Each alternative would provide a different level of detail for the data and would also provide different utilities for the data for future phases of the project or other uses by stakeholders. Within alternatives 3A and 3B, different levels of detail can be achieved depending on the level of accuracy desired for the data.

The following summarizes the tasks required and data types needed for any of these alternatives. Estimates of budget for each alternative are based on providing the listed deliverables for any alternative.

A summary list of data needed for Flood Damage Assessment and Benefit-Cost Analysis is provided below:

- Damage History:
  - Public property damage summaries
  - Private property insurance claims
  - Details of storm event
    - Areas of inundation
    - High water marks
- Additional hazard data (TO BE COLLECTED IN SEPARATE PHASE)
  - Historic erosion data
  - Sea level rise projections
  - Effective floodplain mapping
- Property Data:
  - Private:
    - Property owner
    - Location (lat/longitude, address)
    - Building/structure type
    - Building /structure size (number of floors, square footage)
    - Building/structure lowest floor elevation
    - Building/structure replacement value
    - Building/structure displacement cost
    - Past insurance claims
  - Public (in addition to similar physical structure information)
    - Critical facility determination
    - Functional Losses
      - Cost/day of loss of public service
      - Cost of slow response or increased risk of poor service
    - Number of customers served
- Population and Economic Data:
  - Tax assessment data
  - Tourism statistics
  - Population projections
- Mitigation/Adaptation Alternative Costs: (TO BE COLLECTED/DEVELOPED IN SEPARATE PHASE)
  - Pre-construction or non-construction costs
  - Construction costs
  - Ancillary costs
  - Maintenance costs

The following summarizes the scope of services required for the structures/infrastructure inventory.

I. Structure/Facility/Roadways Inventory – for each community
The JMT team will conduct an inventory on the structures, facilities and roadways located within and in close proximity to the delineated coastal hazards for each of the seven identified communities. Data will be collected for each of the structures, facilities and roadways located within the geographic study area limits shown on figures developed as part of Task Order 1. The inventory will include:
   a. Structures/Facilities/Roadway Location
   Mapping showing location of structures, facilities and roadways will be prepared using GIS so that latitude/longitude data can be associated with structures.
   b. Roadway Data
   Centerline profile elevation, location of bridges/culverts and intersections will be obtained and presented on mapping.
   c. Building data
   The following types of building information will be obtained.
      i. Ownership
      ii. Location - address
      iii. Size, type, foundation, etc.
      iv. Tax value, replacement value
      v. Damage/Claims History
      vi. Photographs

   The source of data to be used will depend on the alternative selected for elevation data collection. However, the above data will be mined from existing data sets owned/managed by the State of Delaware and/or each of the Counties.

II. Elevation Data
Elevation data will be collected using one of the alternatives presented above. The results will be tabulated for each community.

III. GIS/Database Development
The JMT team will develop a GIS and database to capture the information collected. For each structure a link to the structure inventory and photographs will be included.

Deliverables:

- Table summarizing key data features for each structure within each community
- Photograph documentation of each structure
- Plan depicting road network with elevations
- Elevation/topographic data that can be used for other applications for the project
- Structure Inventory Form for each structure

Background Information for Evaluating Proposed Options
Mobile LiDAR Data Collection

One of the options proposed for collecting elevation and location data for structures is the use of Mobile LiDAR technologies. The following is a summary of the approach and potential benefits of using this technology on the Economic Analysis of the Delaware Bay Shoreline Adaptation Alternatives project. Also, a summary of the successful application of this technology for a similar project is provided.

Baker Mobile LiDAR

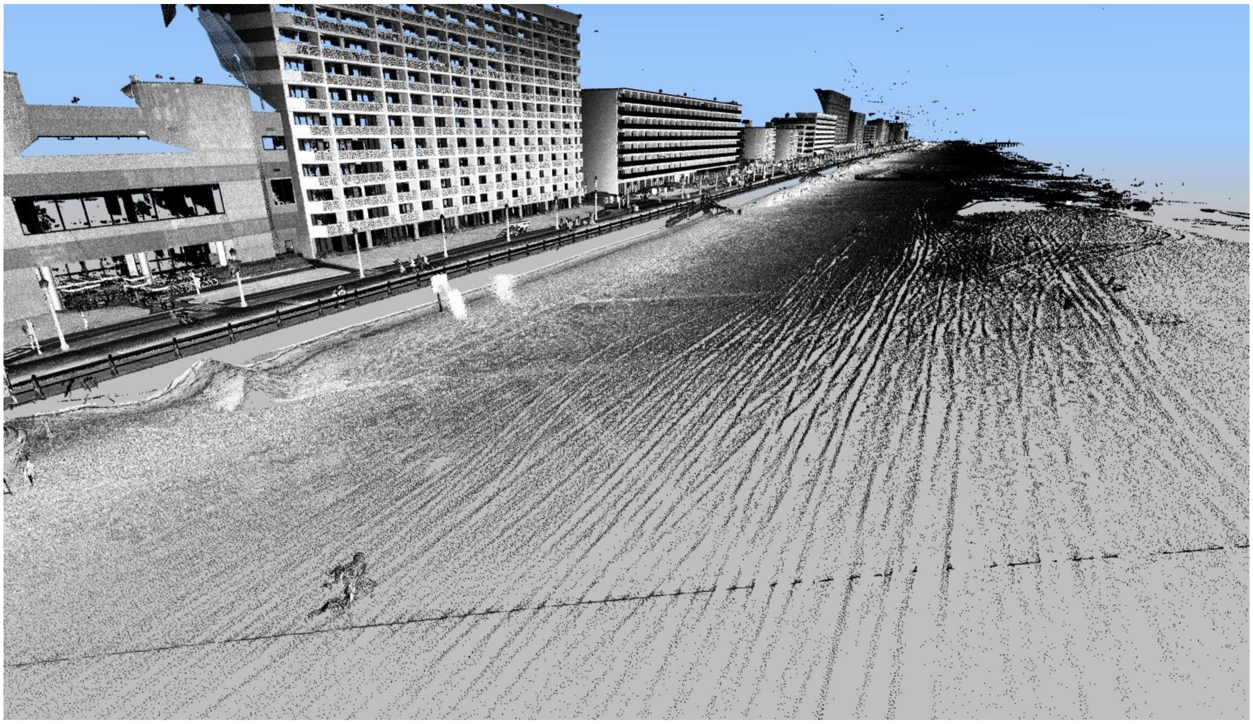
For purposes of collecting highly detailed structure elevation information, a mobile LiDAR system should be considered. Baker owns and operates a mobile LiDAR unit which includes state-of-the-art sensors that can effectively blanket a 235 meter-wide collection swath yielding dense elevation data at survey-grade accuracy. This unit can provide elevation data with resolution of up to 1 cm and vertical accuracy of approximately 1/10 ft. Digital photos of the entire survey are also collected simultaneously with the elevation data.

If the study team decides to use a highly detailed approach (i.e. Alternative 3B), the unit can be used to collect first floor elevation data and digital photo images of structures throughout the Delaware Bay communities. Collected elevations can be included in a relational geodatabase which associates each structure to a corresponding parcel, owner, address, assessed value, photo-image, and any other information deemed critical to the study.

Baker has recently performed similar work for the U.S. Army Corps of Engineers in Bossier City, Louisiana (see attached project summary sheet). An example of one of the products delivered for this project is provided below:

A preliminary cost estimate for building a similar product for the eight Delaware Bay communities included in the study is $xx to $xx per structure. Actual unit costs will vary depending on accuracy requirements, building density, mobilization of the unit, and other scoping decisions. It is important to note that this information would be valuable to other local, state, and federal stakeholders.

In addition, the mobile LiDAR system could be used to collect highly detailed elevation data for beach-dune systems along the Delaware Bay. This data may be very useful depending on the need to update shoreline change rate data or construct near shore beach profiles for purposes of coastal modeling. Two examples of similar data collected in the City of Virginia Beach, Virginia are provided below:



Mobile LiDAR Finished-Floor Elevation Survey

Bossier City, Louisiana

Project Number: AGMT S-AG-062410
Agreement Number: S-AG-062410

Project Type:
Public

Baker's Role:

- Topographic survey
- Mobile LiDAR data collection
- Digital photography
- Geodatabase development
- Survey engineering report
- Finished Floor Elevations

Baker performed a detailed survey of approximately 1,300 structures to establish finished floor elevations (FFE), using data acquired by Baker's Mobile LiDAR (Light Detection and Ranging) system. Baker developed a relational geodatabase of the survey-grade FFE locations to spatially associate each structure with its corresponding parcel, owner, address, and assessed value, and further prepared a survey engineering report.

The project required collection of survey-grade data with a level of vertical accuracy consistent with third-order elevations for the entire area. To properly constrain the LiDAR data, Baker first recovered geodetic control within the region, then performed rapid static GPS observations on LiDAR identifiable control points established by the field crews. Utilizing the GPS-derived ground control points, the Mobile LiDAR collections were fully constrained to meet the US Army Corps of Engineers Vicksburg Districts' (Corps) survey requirements.

Baker's Mobile LiDAR equipment includes state-of-the-art sensors that can effectively blanket a 235 meter-wide collection swath with up to 400,000 laser shots per second; each to survey-grade accuracy. The Mobile LiDAR system also included two, five-megapixel digital cameras firing at 3 frames per second, that were utilized to capture multiple viewing perspectives of each structure throughout the survey, to support quality assurance/quality control (QA/QC) validations, and by associating each image to its corresponding FFE location, enhance the GIS system.

By employing the services of Baker's Mobile LiDAR system, the Corps realized significant cost savings over traditional rod and stick survey methods, by significantly increased field collection efficiency, data standardization, and consistent spatial accuracy. Additionally, the system provided comprehensive coverage of the entire worksite, which enabled the identification of 267 structures previously unknown to the Corps or the Bossier City Tax Assessor.